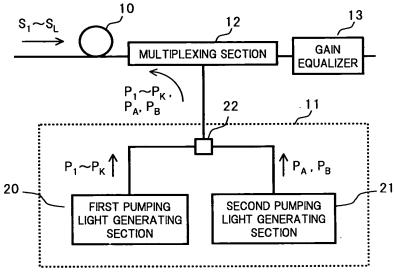
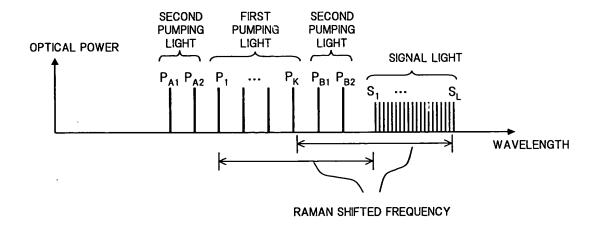
1/30

#### RAMAN AMPLIFIER OF FIRST EMBODIMENT OF PRESENT INVENTION



MULTI-WAVELENGTHS PUMPING LIGHT SOURCE

FIG.2



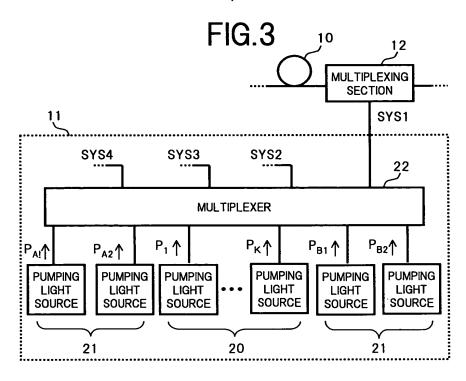


FIG.4

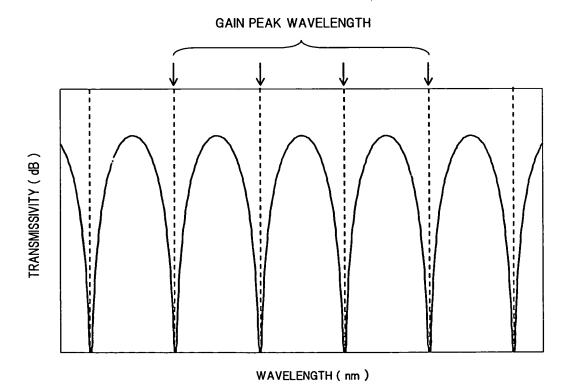


FIG.5



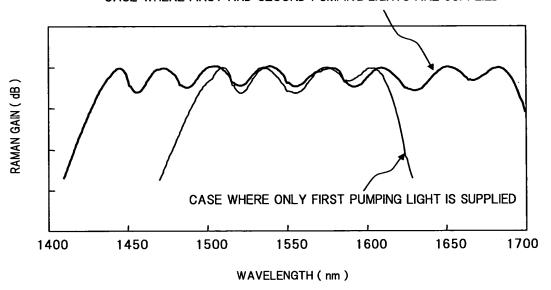


FIG.6

#### RAMAN AMPLIFIER OF SECOND EMBODIMENT OF PRESENT INVENTION

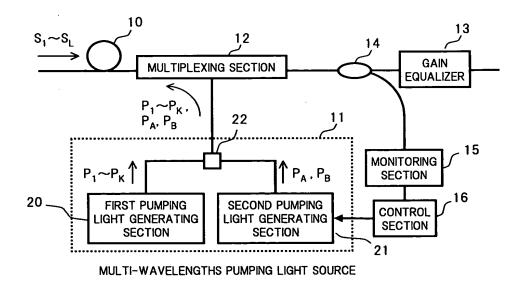


FIG.7

### RAMAN AMPLIFIER OF THIRD EMBODIMENT OF PRESENT INVENTION

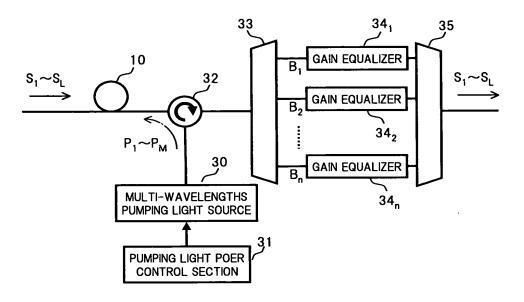


FIG.8

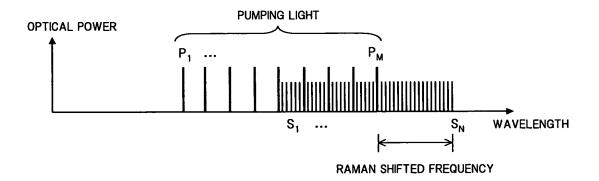
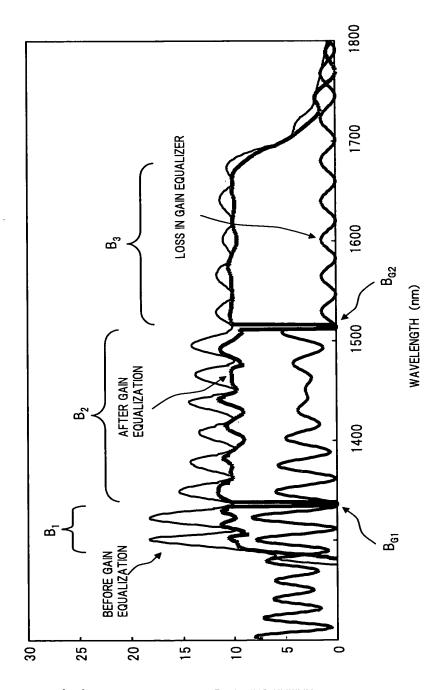


FIG.9



RAMAN GAIN OR LOSS IN GAI EQUALIZER (dB)

6/30

**FIG.10** 

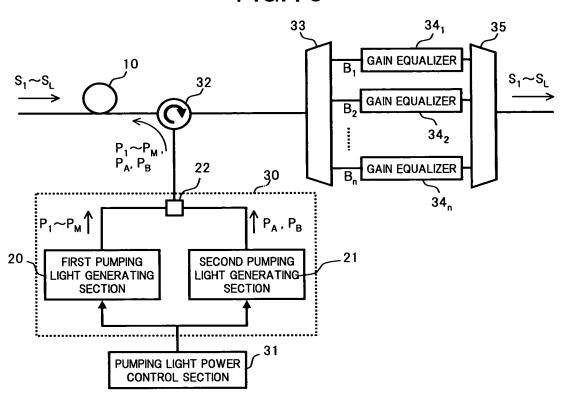
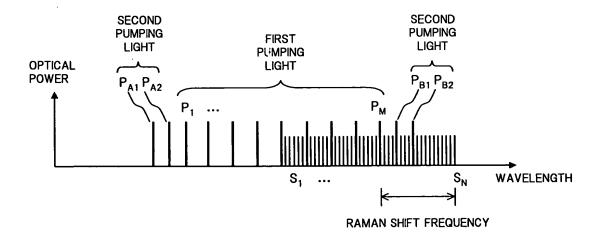


FIG.11



### RAMAN AMPLIFIER OF FOURTH EMBODIMENT OF PRESENT INVENTION

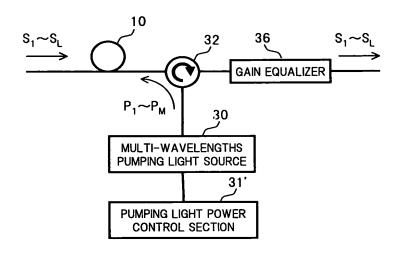


FIG.13

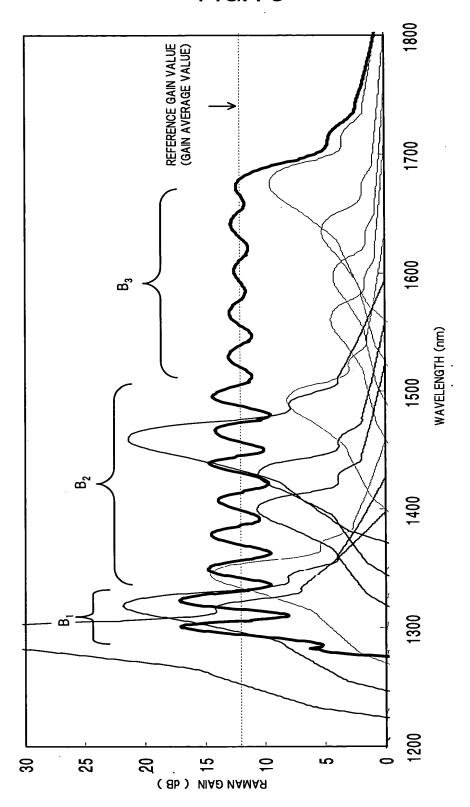


FIG.14

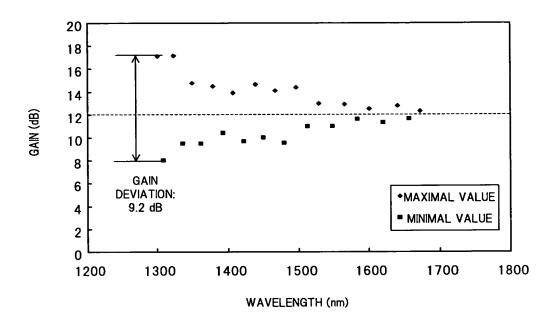
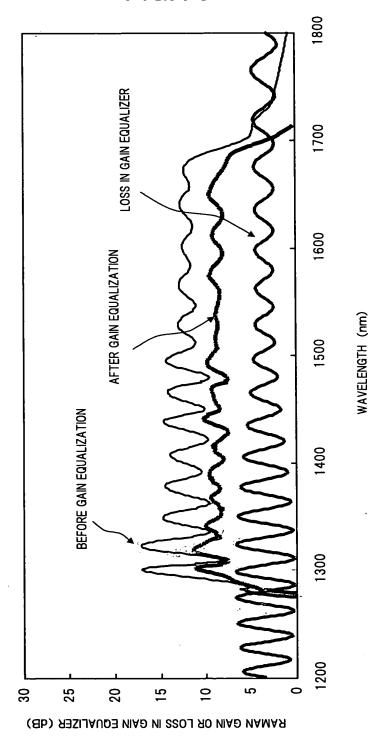


FIG.15



**FIG.16** 

### RAMAN AMPLIFIER OF FIFTH EMBODIMENT OF PRESENT INVENTION

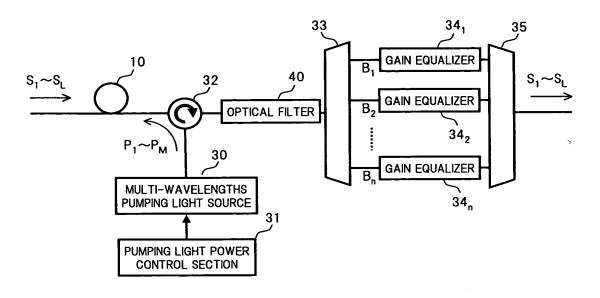


FIG.17

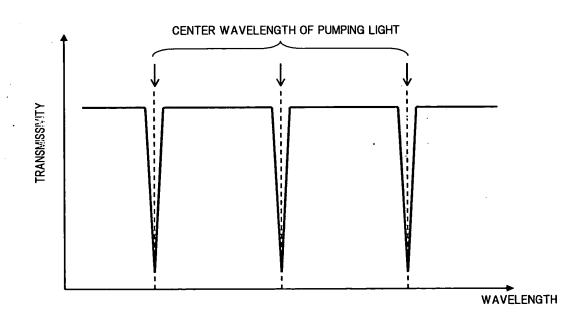


FIG.18

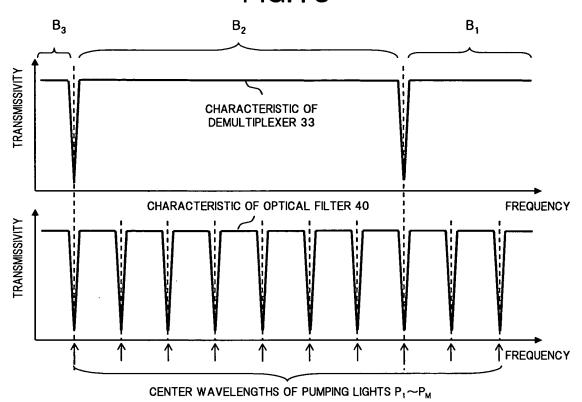
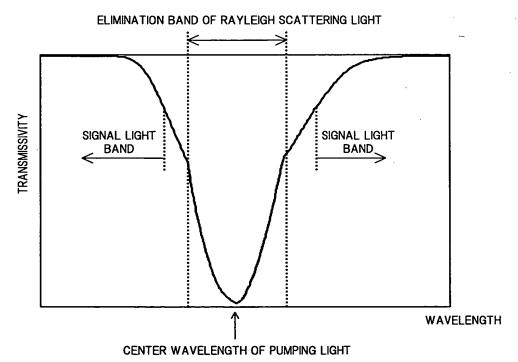


FIG.19



**FIG.20** 

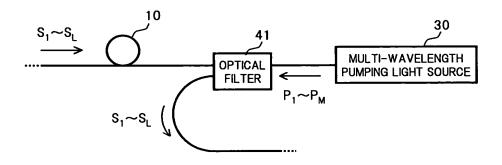
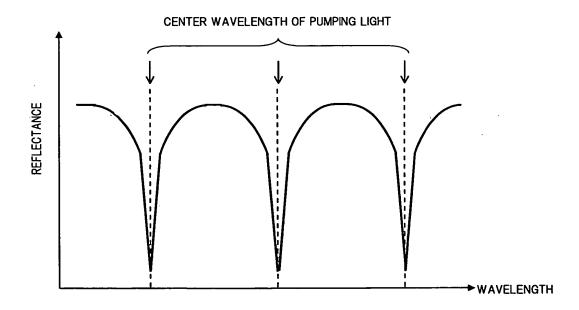
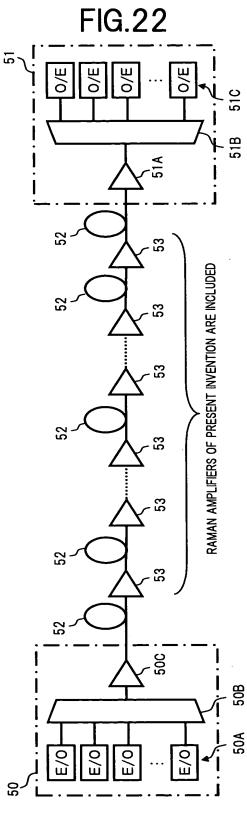


FIG. 21

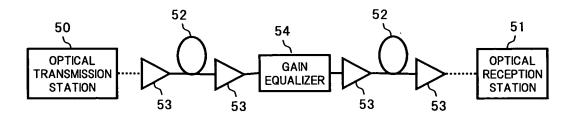


OPTICAL TRANSMISSION SYSTEM ACCORDING TO SIXTH EMBODIMENT OF PRESENT INVENTION

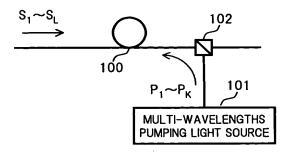


14/30

**FIG.23** 

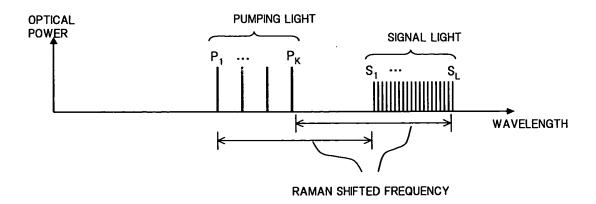


### CONFIGURATION EXAMPLE OF CONVENTIONAL RAMAN AMPLIFIER

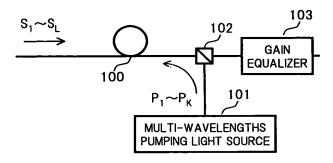


## **FIG.25**

### WAVELENGTH ALLOCATION EXAMPLE IN CONVENTIONAL RAMAN AMPLIFIER

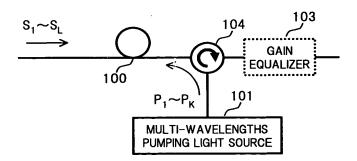


#### ANOTHER CONFIGURATION EXAMPLE OF CONVENTIONAL RAMAN AMPLIFIER



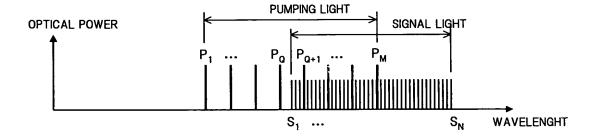
### **FIG.27**

#### ANOTHER CONFIGURATION EXAMPLE OF CONVENTIONAL RAMAN AMPLIFIER



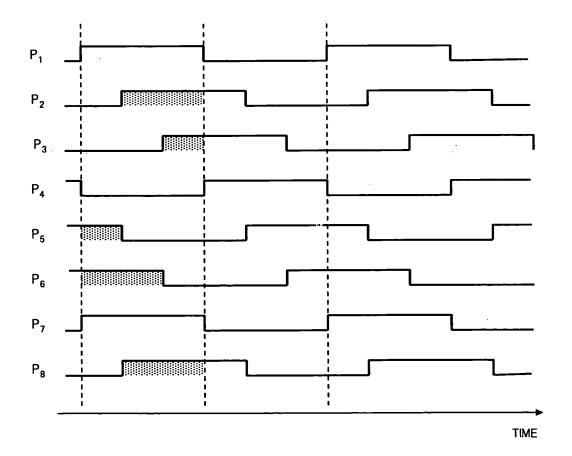
**FIG.28** 

### ANOTHER WAVELENGTH ALLOCATION EXAMPLE IN CONVENTIONAL RAMAN AMPLIFIER



**FIG.29** 

### EXAMPLE MODULATION SYSTEM FOR PUMPING LIGHT

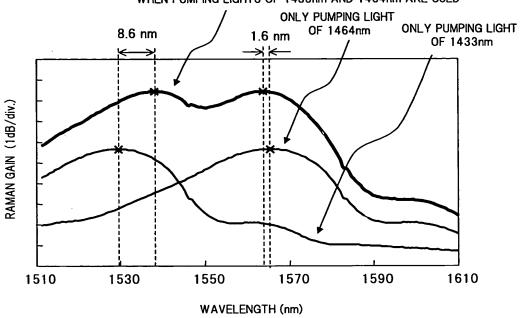


19/30

**FIG.30** 

### CHANGE IN PEAK WAVELENGTH OF TYPICAL RAMAN GAIN

WHEN PUMPING LIGHTS OF 1433nm AND 1464nm ARE USED



**FIG.31** 

#### EXAMPLE OF CASE WHERE PUMPING LIGHT IS ARRANGED AT UNEQUAL INTERVAL

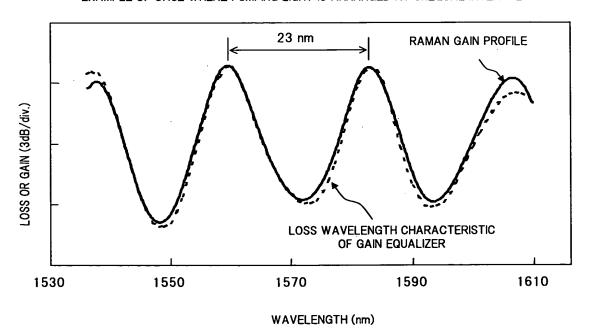


FIG.32

EXAMPLE OF WAVELENGTH ALLOCATION IN WHICH SINGLE PUMPING LIGHT IS MIXED IN SIGNAL LIGHT BAND

20/30

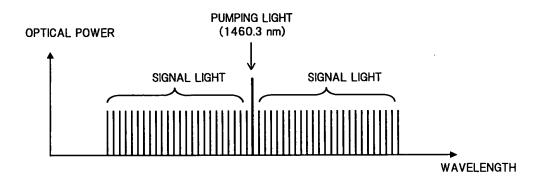


FIG.33

### RAMAN EFFECT BY PUMPING LIGHT OF 1460.3 nm

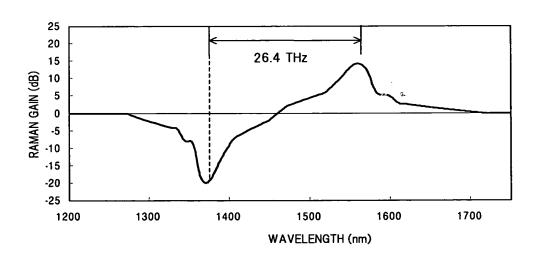
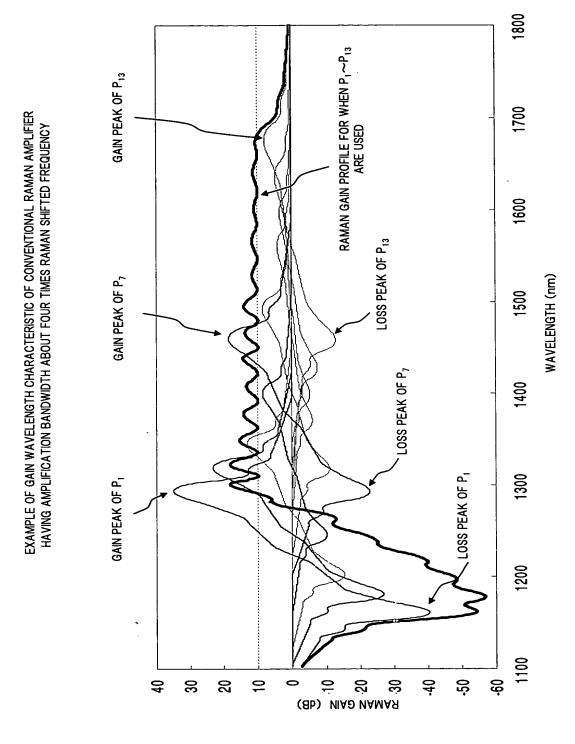


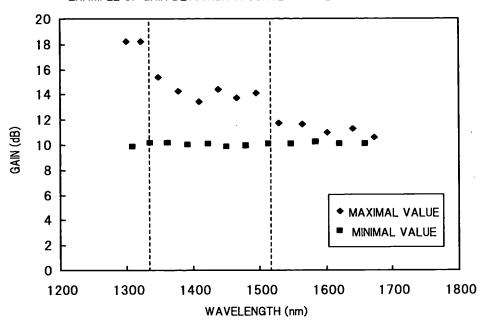
FIG.34



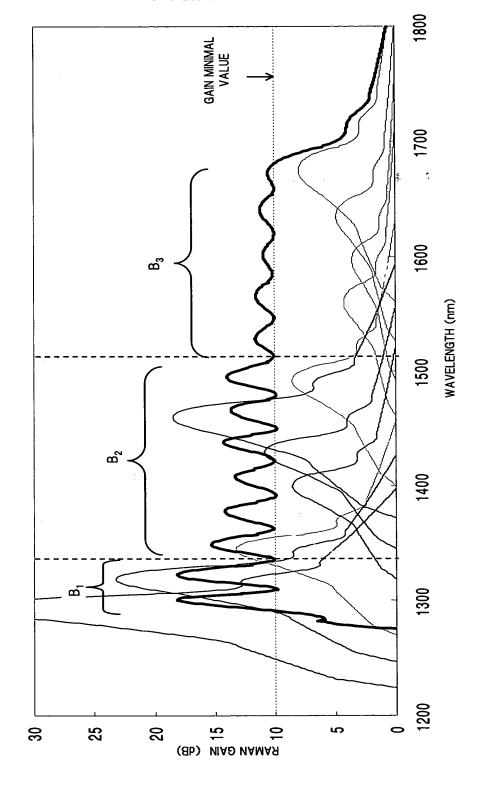
22/30

FIG.35

EXAMPLE OF GAIN DEVIATION IN CONVENTIONAL RAMAN AMPLIFIER

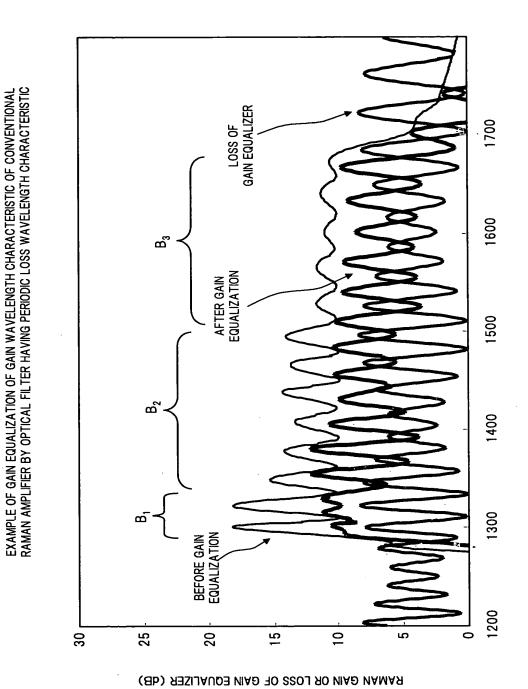


**FIG.36** 



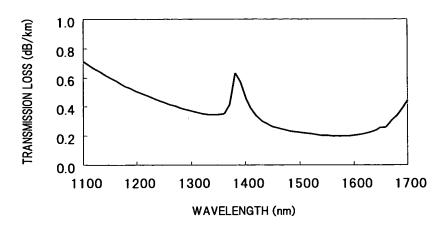
ENLARGED VIEW OF GAIN WAVELENGTH CHARACTERISTIC OF CONVENTIONAL RAMAN AMPLIFIER HAVING AMPLIFICATION BANDWIDTH ABOUT FOUR TIMES RAMAN SHIFTED FREQUENCY

**FIG.37** 



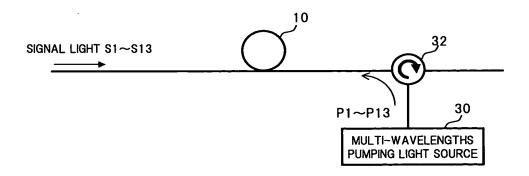
WAVELENGTH (nm)

## TRANSMISSION LOSS WAVELENGTH CHARACTERISTIC OF TYPICAL SINGLE-MODE OPTICAL FIBER



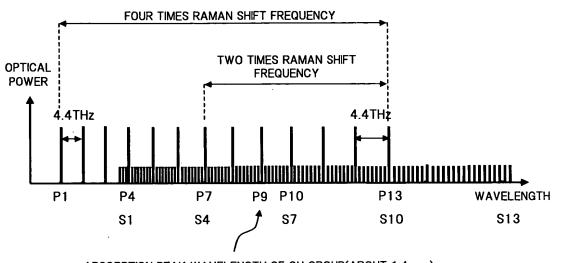
## **FIG.39**

### CONFIGURATION OF RAMAN AMPLIFIER IN SEVENTH AND EIGHTH EMBODIMENTS



26/30

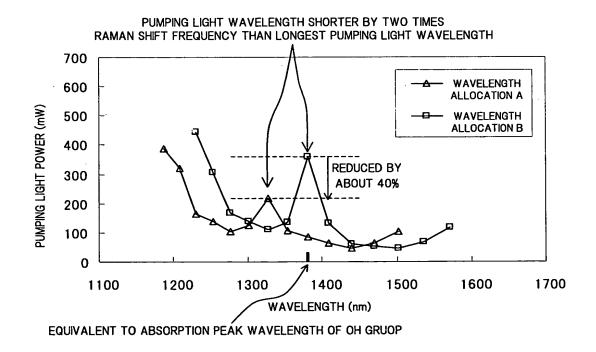
### WAVELENGTH ALLOCATION (WAVELENGTH ALLOCATION A) IN SEVENTH EMBODIMENT



ABSORPTION PEAK WAVELENGTH OF OH GROUP(ABOUT 1.4  $\mu$  m)

**FIG.41** 

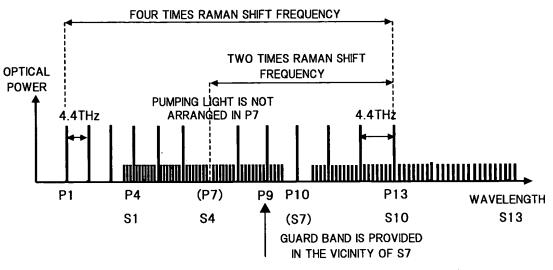
#### **EFFECT IN EMBODIMENT**



27/30

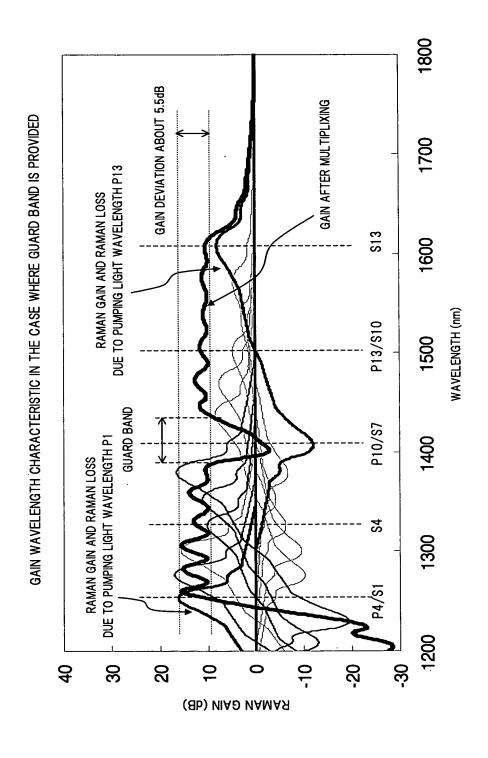
**FIG.42** 

# WAVELENGTH ALLOCATION IN THE CASE WHERE GUARD BAND IS PROVIDED (WAVELENGTH ALLOCATION C)



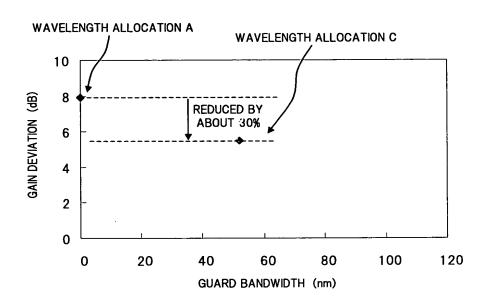
ABSORPTION PEAK WAVELENGTH OF OH GROUP (ABOUT 1.4  $\mu$  m)

28/30 FIG.43



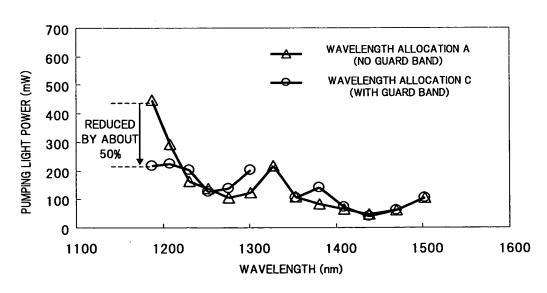
<sup>29/30</sup> FIG.44

### GAIN DEVIATION REDUCTION DUE TO PROVISION OF GUARD BAND



**FIG.45** 

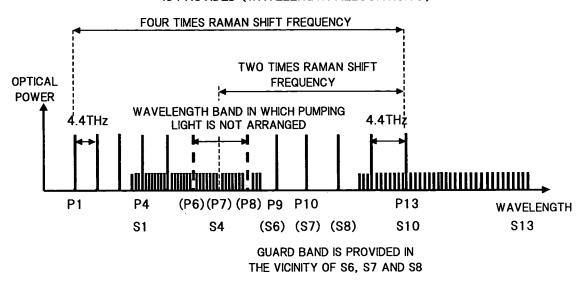
### PUMPING LIGHT POWER IN THE CASE WHERE GUARD BAND IS PROVIDED



30/30

**FIG.46** 

### WAVELENGTH ALLOCATION 2 IN THE CASE WHERE GUARD BAND IS PROVIDED (WAVELENGTH ALLOCATION D)



**FIG.47** 

#### GAIN DEVIATION REDUCTION 2 DUE TO PROVISION OF GUARD BAND

